were observed for the reconstructed dose distributions based on the MLC logs.

Conclusions: All participating sites demonstrated acceptable implementation of VMAT delivery achieving 3%/3mm γ pass rates > 90% for the external dosimetry audit. The reported in-house QA results were consistent with the audit despite differences in dosimetry equipment and analysis methods. Mobius provided remote data analysis for independent assessment of TPS dose calculation and VMAT delivery.

References:
(1) Tsang et al, BJR, 2013
(2) Clark et al, R&O, in press
(3) Kry et al, IJROBP, 2014

PO-0991

The role of complexity metrics in a multi-institutional dosimetry audit of VMAT

C.K. Mc Garry[1,4], C.E. Agnew[1], M. Hussein[2,5], Y. Tsang[3], A.R. Hounsell[1,4], C.H. Clark[2,6]

[1]Northern Ireland Cancer Centre Belfast Health and Social Care Trust, Radiotherapy Physics, Belfast, United Kingdom
[2]Royal Surrey County Hospital NHS Foundation Trust, Department of Medical Physics, Guildford, United Kingdom
[3]Mount Vernon Hospital, Radiotherapy Trials Quality Assurance (RTTQA), Northwood, United Kingdom
[4]Centre for Cancer Research and Cell Biology, Queen's University, Belfast, United Kingdom
[5]University of Surrey, Guildford, United Kingdom
[6]National Physical Laboratory, Radiation Dosimetry, Teddington, United Kingdom

Purpose/Objective: To demonstrate the utility of complexity metrics such as the modulation complexity score (MCS) and monitor units (MU) in multi-institutional audits of VMAT treatment delivery.

Materials and Methods: 39 VMAT treatment plans from 34 UK radiotherapy centres were analysed using MCS and MU. A virtual phantom planning exercise (3DTPS plan [1]) was planned and independently measured in each institution using the PTW Octavius phantom and PTW seven29 2D Array combination [2-3]. The global gamma index with a 20% threshold relative to a point selected in a high-dose, low-gradient region, was used to compare the measured and predicted dose distributions. MCS and MU were compared to the average gamma index pass rates (2%2mm & 3%3mm) of the plans in two coronal planes and a sagittal plane. The TPS were grouped according to whether VMAT modelling had been specifically designed for the linac manufacturer's own treatment delivery system (Type 1: Eclipse) or had been designed to be independent of vendor or VMAT delivery (Type 2: Monaco, OMP and Pinnacle). Differences in plan complexity (MCS and MU) between treatment planning system types were compared using a student t-test. Correlations were made between the metrics and gamma pass rate using Pearson correlations. Statistical significance was set at $p<0.05$.

Results: Table 1 shows that MCS and MU were significantly correlated with gamma pass rate when all 39 linac / treatment planning system (TPS) combinations were analysed. For Varian linear accelerators, significant correlations were observed for both MCS and MU compared with gamma pass rates. No correlation was observed between complexity metrics and the pass rates for Elekta linear accelerators. This may have been due to the fact that all Elekta linacs used Type 2 treatment planning systems. Type 2 planning systems created more complex plans with significantly lower MCS ($p<0.001$) and significantly higher MUs ($p=0.018$) compared to Type 1 planning systems. ?Figure 1 shows a statistically significant correlation was observed between MU and MCS for all plans ($R=-0.85$, $p<0.001$).

					Correlation with MCS		Correlation with MU	
	MCS	MU	3%3mm	2%2mm	3%/3mm	2%/2mm	3%/3mm	2%/2mm
All Linacs (n=39)	0.225 (0.059)	760 (189)	99.7 (84.0-100.0)	95.5 (50.5-100.0)	R=0.46 (p=0.003)	R=0.46 (p=0.003)	R=-0.42 (p=0.008)	R=-0.39 (p=0.014)
Varian (n=26)	0.247 (0.052)	710 (156)	100.0 (84.0-100.0)	97.6 (50.5-100.0)	R=0.62 (<0.001)	R=0.52 (p<0.001)	R=-0.54 (0.004)	R=-0.40 (p=0.04)
Elekta (n=13)	0.180 (0.046)	858 (216)	98.1 (86.9-100.0)	85.6 (55.6-100.0)	R=-0.12 (p=0.70)	R=-0.17 (p=0.58)	R=-0.10 (p=0.75)	R=-0.11 (p=0.72)
Type 1 (n=22)	0.251 (0.039)	697 (111)	100 (95.0-100.0)	98.1 (78.6-100.0)	R=0.34 (p=0.16)	R=0.43 (p=0.05)	R=-0.19 (p=0.48)	R=-0.41 (p=0.08)
Type 2 (n=17)	0.190 (0.063)	841 (237)	98.1 (84.0-100.0)	85.6 (50.5-100.0)	R=0.24 (p=0.35)	R=0.15 (p=0.56)	R=-0.31 (p=0.23)	R=-0.28 (p=0.28)

Table 1: Modulation Complexity Score (MCS) and Monitor Units (MU) showing mean (standard deviation). Gamma pass rates (2%2mm and 3%3mm) showing median (range). Also shown are Pearson correlations between MCS and MU with gamma pass rate with associated p-values.

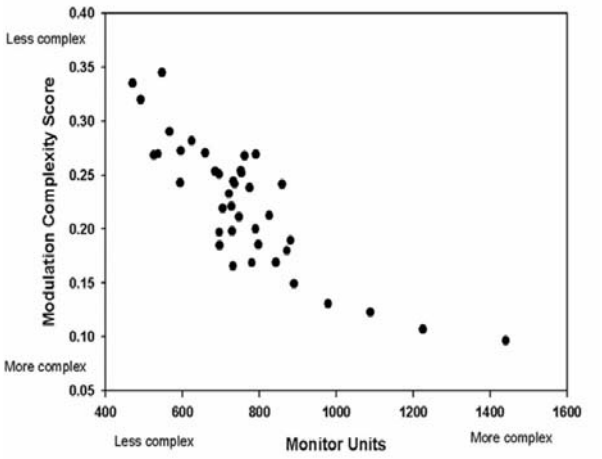

Figure 1: Plot of modulation complexity score against monitor units for all 39 plans.

Conclusions: MU and MCS can be used as surrogate for complexity under audit conditions. MU and MCS provide a useful guide of how complex a plan is and these give some indication of plan deliverability.

References
[1] Tsang et al Br J Radiol 2013: 86; 1022. [2] Hussein et al R&O 2013 108(1):78-85. [3] Clark CH et al R&O 2014 in press.